The Engineering News.

A Journal of Practical Science and Public Improvements.

PUBLISHED MONTHLY.

SEPTEMBER 15th, 1875.

Announcement.

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The Society now numbers 72 members, each of whom, by agreement, becomes a subscriber to ENGINEERING NEWS, and so increases our subscription list quite materially, while adding very greatly to the influence of our journal. The list of members, which is published in another column, includes the names of several of the most eminent Engineers and Railway officers on the continent, and is a fair indication of the strength of a society, which must ere long become an important factor in the material advancement of the North-west, and whose individual members must always be among the leading contributors to the industrial developement of the whole country.

The advantages of our official connection with the Engineers' Club will be three-fold; the members, knowing that their intellectual efforts are to be laid before a wide and intelligent constituency, will be stimulated to a higher degree of excellence than heretofore in the preparation of papers; the readers of ENGINEERING NEWS will receive the benefit each month of well prepared original articles on subjects of practical importance, which could not otherwise be obtained, but by becoming members of the Society; while we expect to be incited to new efforts in behalf of Engineering and general Scientific progess in America, and by the public endorsement, of an influential society be enabled more rapidy to win the material encouragement of large numbers of the Engineering profession of the country.

Engineering Journalism.

The periodical literature of engineering enjoys an advantage not possessed by that of medicine, or of law. Few besides those already in the medical profession, or those who are preparing for it, care to read reports of hospital cases, or essays upon curative science. Few who are not in the law, or reading for admission, care to dive into equity reports, or to analyse judicial decisions. Professions which have to deal respectively with human suffering and human wrong, lack attractiveness, however the labors of their professors may be valued and honored. But engineering, even to the gaze of laymen, opens up a world of magic, and its achievements surpass the fiction of mythology and the storied marvels of enchantment. To reclaim a province from the sea, to float a navy in an artificial harbor, where before were only shallows and sands, to hew a channel and to bring a river of pure water through a mountain and through miles of rocky wastes for the supply of a great city, all are works which inspire wonder and admiration in the minds of men, from the highest to the lowest. But it has been with steam that engineers have worked out the greatest marvels in history, and it is the application of steam in a hundred ways that will always give to engineering its great hold upon popular appreciation. It is for this reason that engineering publications will always be more or less read by those who live quite out of the profession. It is this fact, we think, which has so long served to maintain the strong tendency to dilettanteism and impracticability which has been so much indulged in by various periodical works more or less professing engineering science. With this profession they have given us only a host of inventions, easily accessible at the Patent Office, and of the practicability of which only a portion of their readers would be able to form an opinion of any value. And there has been a great deal of irresponsible writing, the conclusions of which have no indefinite application.

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Astronomical Notes.—No. VII.

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tween the sixth and tenth magnitudes. He considers the theory that it turns like our moon, presenting always the same side to the planet, at least probable, and, in that case, its most luminous hemisphere is that which is turned toward the sun when the satellite is in the west superior quarter of its orbit, and its least luminous that turned towards the sun when the satellite occupies the east inferior quarter. This hypothesis does not, he says, account for all the variations observed; there are atmospheric revolutions which make the reflecting surface vary at several points of the orbit.

Dr. Doberck, who seems to be giving special attention to this subject, has calculated the elements of the binary pair, ζ Aquarii (Σ 2909), and finds a periodic time of 1578 years. The measures of all the principal observers, from Sir William Herschel in 1781, to Dembowski in 1869, are discussed, but the result can be little better than an approximation, as the angle since the date of the first careful measures, by Struve, in 1836, has changed only 15°, the distance remaining nearly the same.

Mr. Tebbutt, of New South Wales, announces the discovery of a comet on May 7th, supposed to be Encke's well known comet of short period. If this is the case, it is the second time he has detected the same object in advance of other observers. It is to be hoped early observations of position will be made by Southern Astronomers, which will doubtless be followed up by the English and American observatories.

No. 147 of the minor planets has been added by Schulhof, at the Observatory of Vienna. It was found on the night of July 10th, near β Capricorni, and is estimated of the twelfth magnitude. No. 148 was discovered by Henry, at Paris, on the night of August 7th. It is noted as a star of the 10.7 magnitude. The place at that time was: R. A. 22°39′3″, Dec'l—11°11′.

In a late number of the *Astronomische Nachrichten* attention is called to an error of 180° in Struve's angle of $O\,\Sigma$ 537. The companion has been seen and readily observed with a small glass several times, but on other occasions has been only barely visible, if at all, with much larger apertures, leading to the suspicion that it may be variable. As it is one of the comparatively recent additions to the Pulkowa Catalogue, it has received but little attention.

Dr. Duner, of the observatory of Lund, Sweden, has calculated the elements of the binary star η Cassiopeae, from the observations made between 1782 and 1874. He makes the period 175.37 years.

Prof. Schonfeld has published a continuation of the series of observations commenced in 1860, for the determination of the places of a selected list of nebulæ, giving the position of 336 of these objects, by comparison with stars carefully observed by Argelander. The differences from Schultz's Catalogue are shown, and are generally small. As one of the results of these later measurements, it is stated that the apparent proper motion of the great nebula in Andromeda, which appeared to be indicated by comparing Flamsteed's observations with those of D'Agelet and Lalande, is not confirmed.

Wabash Avenue is to be paved, and the contractors have commenced work. It is to be considerably wider than before.

PUBLICATIONS RECEIVED.

THE COAL TRADE. A compendium of valuable information, by Frederick E. Saward, Editor of the "Coal Trade Journal." New York, 1875. Price 50 cents.

This valuable little work, of 100 pages, contains a vast variety of information regarding the production, composition, and characteristics of coal in almost all the countries of this continent and Europe. All the coal producing States of the Union are represented in this book, with the statistics relating to price, production, shipments, analysis, wages, and other items included in cost of production, carefully classified and abundantly elucidated by supplementary remarks. Engineers and steam users generally, are often called upon to decide which of various classes and brands of coal is best suited to the particular object which they have in view. It may be that a high pressure and rapid production of steam is required, in which case (other things being equal) an anthracite of a certain quality would probably be sought for. Or, perhaps, the opposite requirements are the requisites; in either case the work under review will save a considerable amount of valuable time in informing the possessor at once and with certainty on the questions he wishes to decide. Space will not allow of a detailed account of the contents of the book, we can here merely indicate some of the valuable information contained therein. Not only are the production and prices of coal in all our coal producing States and Territories (also in Novia Scotia and New Brunswick) carefully detailed, and the topography of the various mining districts and geological sections illustrated, but also the particulars of the trade at the principal shipping ports of New York, Port Richmond, Pittsburgh, Cincinnati, Cleveland, Chicago, St. Louis, Baltimore, San Francisco, &c., &c., are fully elucidated. The book concludes with a number of "useful facts and figures," rules for wire ropes, testing coal, underground temperature, weight of T-rail, modes of working coal, weights and measures, and many tables which serves to make the little work a very complete compendium of all that relates to coal, and of value to every one who feels any interest whatever in one of our two largest industries—coal and iron.

JULY TRANSACTIONS of the American Society of Civil Engineers.

From the Institution of Civil Engineers—

USE OF FASCINES IN THE PUBLIC WORKS OF HOLLAND, by T. C. Watson, M. Inst. C. E.

THE HULL DOCKS, by Sir Wm. Wright, Asso. Inst. C. E., and THE ALBERT DOCK, Hull, by J. C. Hawkshaw, M. A. M. Inst. C. E.

ON THE SEPARATE SYSTEM OF SEWERING the Dist. of Tottenham, Middlesex, by James Pilbrow, M. Inst. C. E.

RAILWAY MANAGEMENT, comprising the following papers:—The working of Railways; on Sorting Railway Trains by Gravitation; on Railway Statistics. By Messrs. Findlay, Cudworth, and Harrison, MM. Inst. C. E.

ON THE DRIVING OF PILES, to resist the force of Ice tending to draw them from the ground. By J. W. James, M. Inst. C. E.

PEAT WORKS IN RUSSIA. By William Anderson, M. Inst. C. E.

REPORT OF THE SUPERINTENDENT of the City of Norwich Water Works, to the Board of Water Commissioners, for five years from April 1, 1870, to March 31, 1875. H. B. Winship, Supt.

Law and Legislation.

An abstract of decisions of the Supreme Court of the United States and of the courts of the various States in the Union upon questions relating to boundaries, surveys, etc. Compiled for the ENGINEERING NEWS by John Dunn, Esq., Attorney at law.

285. Where lands are bounded by a stream, or river not navigable or above tide water, the grantee takes *usque filum aqua*, unless the stream or river be expressly excluded from the grant by the terms of the deed. Demeyer v. Legg. 18 Barb. (N. Y.) 14.

286. In applying this principle to the construction of a deed, it need not be proved, in terms, that the stream was not navigable or above tide water, if that fact sufficiently appears from other evidence in the case, and the objection that no such proof was made, comes too late on a motion for a new trial, if it was not taken at the trial. [Ibid.]

287. The proprietors on the borders of Lake Champlain must be deemed the owners to low water mark, unless otherwise limited by the terms of their grants. It seems pretty well settled in New York that a grant bounded upon a river generally, above tide water, takes to the thread of the stream, subject to the service of the public interest for purposes of navigation. This principle does not apply to the lakes. Champlain Railroad v. Valentine, 19 Barb. (N. Y.) 484.

288. Where there are two objects or lines answering the call of a deed, and it appears that the grantor owns up to the first, but does not own the space between the two, that which the call first meets is the boundary. Hunt v. Francis, 5 Ind. (302).

289. Where the description in a deed bounds land conveyed on one side by "an alley," and it appeared that the recorded alley differed in width from the alley in use, it was held that either alley would answer the description in the deed. [Ibid.]

290. The intention of parties, as deduced from the circumstances surrounding them, may be enquired into, to fix a boundary line, where the description in the deed is ambiguous. [Ibid.]

291. All lands are supposed to be actually surveyed, and the intention of the grant is to convey the land according to that actual survey. 16 Geo. 141.

292. If nothing exists to control the call for courses and distances, the land must be bounded by the courses and distances of the grant, according to the magnetic meridian; but courses and distances must yield to natural objects. [Ibid.]

293. Whenever it can be proved that there was a line actually run by a surveyor, which was marked, and a corner made, the party claiming under the grant or deed shall hold accordingly, notwithstanding a mistaken description of the land in the grant or deed. Ibid.]

294. Boundaries and courses may be proved by hearsay, from the necessity of the case. [Ibid.]

295. When a line has been agreed on, by coterminous proprietors, and acquiesced in and possession of it held for eighteen or twenty years, the parties, and those claiming under them, are bound by it, no matter where the line was run. [Ibid.]

296. A mistake in the course or distance, in giv-

ing the bounds of a tract of land, will not be permitted to disappoint the intent of parties, if that intent appears from other certain facts. 1 Jones, Law. (N. C.) 389.

297. In a question of boundary, the distance called for by the deed must govern, unless there be some other description less liable to mistake to control it. Kissam v. Gaylord, Busbee, Law. (N. C.) 116.

298. A deed conveying land, adjoining navigable waters, conveys the shore to low water mark, where the ebb of the sea does not extend beyond one hundred rods. Pike v. Monroe, 35 Maine, 309.

299. Monuments and a line, when described as a monument, control courses and distances. Haynes v. Young, 36 Maine, 557.

300. Where two surveys call for each other, there can be no vacancy, unless the lines marked on the ground contradict the call, and in such case the marked lines must govern. McGinnis v. Porter, 20 Penn., 80.

Mathematical Column.

We intend to make our Mathematical column a permanent feature of our Journal, and will endeavor to make it as interesting as possible. We, of course, expect to leave the matter almost entirely to the care of our contributors, who, we trust, will be careful in the selection of questions, and be as brief and simple as possible in their solutions. We hope, also, that the higher mathematics will not be used when more familiar methods will answer equally as well; and we may also say, that it must not be expected that we can go to the expense of illustrating by a diagram, *every* solution that is sent us. Shortly after our Journal was started we procured from New York a supply of type for setting mathematical matter, and we believe we are more fully furnished in that particular than most of the printing offices in this city. We find ourselves in want of "sorts," however, which in time, we expect to procure. At present we have not the material to do justice to questions solved by means of the Calculus, and therefore we do not expect to find favor with our friends who prefer to use that method. With the close of the surveying season a few weeks hence, we will be enabled to give almost our entire attention to our Journal, when we hope to make amends for the many, and rather annoying, blunders that have appeared in this department. In accordance with the suggestion of a contributor, we will number the problems, and No. 1 is the question of the "horse winding a rope about a post," on page 33; No. 2 is the "Elliptical Garden" question, on pg. 48; No. 3, is "to find the mathematical centre of an irregular surface," on page 81; No. 4, is the "fox and dog;" No. 5, is the "point without the square;" No. 6, the "column and statue" question, all on page 95; No. 7, on page 106; Nos. 8 and 9, on page 107; No. 10, on page 108; and succeeding numbers will be found with the questions.

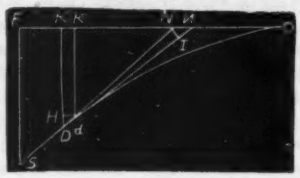
The following solutions have been received:

No. 1. —31416.98 yds.; by W. A. T., Hartford, Ct.
" 1. —31415.95653 yds., by J. M., Mansfield, O.
" 2. —Solution on page 107.
" 4. 133⅓ rods run by fox. 166⅔ rods run by dog. } by J. N.
" 4. 139.2 rods; by W. A. T.
" 5. Side of Square—20 ft.; by J.N. & W.A.T.
" 6. 107.258 ft.—breadth of river; by J. N.
7, 8, 9, 10. See this Number of NEWS.

[11]. Let A be the summit of a hill, of which B is the foot; the lower part of the hill B C is a plane 840.5 yards long, inclined to the horizon at an angle of 12°10′; the elevation of the top of the hill, as seen from B, is 34°20′, as seen from C is 52°12′; find the perpendicular height, in feet, of A above the horizontal plane through B.

[12]. A roof, A C B, is wholly composed of beams forming isosceles triangles, of which A B is the base; find the horizontal thrust on the side walls. Let W—wt. of roof, and φ—angle which it makes with the horizon.

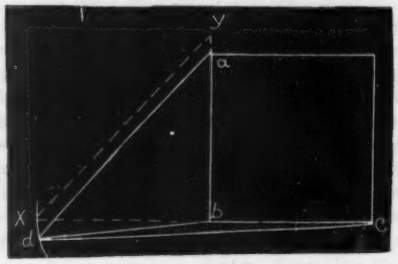
CORRECTION of Solution of the "Fox and Dog" problem, by J. N., in August Number, page 107.



See corrected Diagram. Then after the word "substitute," in the 17th line, read "and we have dy—4-5 dw—5-4 dx, or dx—16-25 dw—4-5 dy." And after "4-5 a," on the 25th line, read, "or x—20-9 a —133⅓ rods then run by the fox. But by the question z—5-4 x—100-36 a—166⅔ rods run by the dog to catch the fox."

SOLUTIONS.

8. 111375 lbs.—pressure. J. N.
9. 18750 lbs.—pressure. J. N.



EDITOR ENGINEERING NEWS:

By your permission, I will present a few ideas to the readers of the NEWS, in regard to some explanations in the mathematical department of the August issue. J. N. says the given numbers in the point and square problem, do not satisfy the conditions of the question, and are absurd. I think he is mistaken.

If we draw two sides of a square, of any sufficient length, then take the distance 40, place the centre of it in the corner of the square, with one-half along the line of the square towards *c*, the other half in a straight line to *x*, now (*x b y* being a right angle), if we lay off the distance 30 from *x* to *y*, it will intersect the continued line *b a*, at a distance of 22.36 from *b*, when the other end of the line 40 will be only 20 from *b* towards *c*. Now, it is evident to me, that if the ends of the lines 30 and 40, which are at *x*, be moved along an arc made by the radius *d b*, (20), the end of the line 30 will come to *a*, and the other end of the line 40 will go to *c*, and be, each, equidistant from the corner of the square, *b*. Therefore the given numbers do satisfy the conditions of the problem, and one side of the square is 20,0736 feet, and the arc, *x d*, =6° 56′ 50″.

In the Fox and Dog problem, M. T., Jr., says, that the dog must run on an elliptic course, but I cannot see from his remarks that it would necessarily be so. An ellipse is a certain curve inscribed within a rectangle, containing a certain part of its area, and as the rectangle approaches to a square, so the curve approaches to a circle. Now, according to this theory, if the dog should run just fast enough to catch the fox, at a distance of 60 rods from the starting point of the fox, the curve would be a circle. Now, would this fulfill the conditions of the question? I think not, because when the dog has run half his distance, the fox will be half of his, and a right line from the fox to the dog would not be a tangent to the circle, and so with all other points. Therefore, I think the ellipse theory to be incorrect.

Can the rate of speed between the fox and dog be so proportioned, all other conditions being the same, so that the dog will describe just one fourth of the circumference of an ellipse, while running for the fox? The distance between the dog and fox, at starting, and the distance run by the fox, being the semi-diameters of said ellipse. Respectfully,

J. J. Whittlesey, O.

MORRISTOWN, N. J., Aug. 30, 1875.

MR. EDITOR:

Solving the problem given in your last issue by B. McG., I find that the point E. is in the line A. B., and that

W E=1145.839 yds.
E O= 979.918 "
W O= 621.587 "

Very respectfully. W. A. C.

MR. EDITOR:

In answer to the problem of B. McG., Liverpool Eng., Trigonometrical Surveying, in ENGINEERING NEWS, Aug. 15, 1875, I send you the following solution:—

The angles A W B and B W E being given, we have E W X.

The angles C E B and B E W being given, we have W E X.

Having W E X and E W X, we get W X E.

Now assume some distance for W E, by which call culate the angles B X A and B X C.

Having found the two last mentioned angles, we proceed to find the distance B X, in accordance with the rules laid down in the Text books for the three point problem, and used to some extent in the coast survey.

The distance B X, being found, and having all the angles, we calculate the distance W E.

The angles O W E and O E W being given, we find W O E. Now, having one side and all the angles of the triangle W O E, we proceed to find the other two sides.

W E=480.12 yards.
E O=410.54 "
W O=260.42 "

Respectfully, M. L., West Point, Neb.

ITHACA, N. Y., Aug. 22, 1875.

MR. EDITOR:

In regard to the Point and Square Problem, please refer to Fig. in July or August number. I wrote ab=bc, and you printed ab=cd. If the latter condition was enforced the thing would be absurd, as a correspondent in the August number states.

Your correspondent, "W. A. T." of Hartford, is mistaken. The size of the square is 20.073 feet. I will send the solution if no one else does so.

Yours, &c., F. A. GAMP.

NEW COMPASS.—A new compass has been invented in France by M. DUCHEMIN, the magnetic force of which resides, not in a bar or needle, as in the ordinary instrument, but in a flat steel ring, magnetized with its poles at two opposite extremities of the same diameter. The ring, supported upon an aluminium traverse, pivoted on agate at its center, has attached to it the ordinary compass card, and acts promptly and efficiently. The inventor claims for it the following advantages:—(1) A magnetic power, double that of a needle whose length is that

of the diameter of the ring; (2) two neutral points instead of one as in the needle; whence it happens that none of the magnetism escapes, and that sparks like those from the Holtz machine do not derange the poles; (3) a better and more prompt performance of the compass, the card seeming to float, as it were, in a liquid; (4) a large increase in the sensitiveness of the instrument; (5) the ability to regulate the magnetic intensity of the ring, and thus to compensate for local causes. This is affected by means of a second magnetized steel ring, smaller than, and inside of, the first, the position of which—and therefore its neutralizing action—may be easily adjusted. Under the direction of tne Minister of the Marine, a trial trip with the new compass was made on the steamboat *Faon* with very satisfactory results. M. DUCHEMIN now proposes, as an improvement, the use of a set of such rings, forming a spherical or spheroidal system of still greater magnetic power.

CORRESPONDENCE.

LANCASTER, WIS., Aug. 22, 1875.

MR. EDITOR:

In reply to brother T. H., of Rochester, Minn., I wish to say, I *did* notice an important typographical error in my reply to his question. It was the substitution of 10 chains in place of 20 chains. This error was so obvious that I did not deem it necessary to correct it.

I understood the diagram referred to, to represent a whole section, and I will endeavor to point out, at least part of the nine quarter corners in the N. W. quarter.

There are three REAL quarter corners, and the section corner is also the corner to a quarter as well, making four; then there is a corner at or near the middle of each boundary line of the quarter and one at the centre, making five more. True, the last five are not quarter corners, but they are the class that I understood brother T. H. to call such. If the types misrepresented him, or I mistook his meaning, then I admit I was "barking up the wrong tree." Now, in regard to ⅛ S. corners, I shall give my reasons, such as they are, for thus naming and marking them. I long since learned, somehow—probably traditionally—that an "eighty" of land properly lies north and south, and that two 1-16 sections, separated by a north and south line, *do not* constitute a legal half-quarter section. My faith in this doctrine has been strengthened by the practice of older and more enlightened surveyors, who would mark a corner 20 chains east or west of a section corner ⅛ S., but would mark corners a like distance north or south of a section corner 1-16 S. But this doctrine, new as it may appear to brother T. H., has some foundation in U.S. law. An Act of Congress Approved Feb'y 22, 1817, provides that Sections 2, 5, 20, 23, 30, and 33, in each and every township of the public lands, shall be offered in quarter sections or half quarter sections, at the option of the purchaser, and in every case of the division of a quarter section, the partition shall be made by a line running *due north and south.*"

The act of April 24, 1820, provides that "All the public lands shall when offered to the highest bidder, be offered in *half quarter sections*, and in every case of the division of a quarter section the line for the division thereof shall run *north and south.*

Act of Congress April 5, 1832, provides that lands may be purchased in quarter quarter sections, "and in every case of the division of a half quarter section the line for a division thereof shall run *east and west.*

The law nowhere mentions an eighth or a sixteenth S, but it plainly describes a half quarter, and that 12 years before it authorized a quarter quarter.

Are the ½ quarters and ⅛ S. corners obsolete because of the introduction of 1-16 corners? No, indeed, no more than ¼ S. corners are obsolete; no more than the section corners are all reduced to 1-16 section corners.

Nothing in regard to half quarter sections has been repealed, and the *Revised* U. S. Statutes as plainly recognizes and describes half quarter sections as any other subdivision of land. I do not seriously object to the marking of all corners less than quarter corners as ¼ ¼ corners or 1-16 S., because in a settled country it is nearly immaterial what marks you make upon a bearing tree, provided you render it easy of identification from the notes, yet I think "T. H." will agree that I have given more plausible reasons and higher authority for my system of nomenclature than mere common parlance. J. B.

LANCASTER, WIS., Aug. 22, 1875.

MR. EDITOR:

I notice that J M., of Shawano, Wis., asks *your* opinion, and you have given it, in relation to a lost quarter corner upon a well blazed line.

My opinion was not called for, but when it is it will require considerable modification to make it agree with yours upon that particular point. If there are station trees upon the line *they* fix the line at those points, however crooked the line may be from tree to tree, but a *blazed* tree is, prima facia, *not on the line.*

We should regard the durability of landmarks, and try to make our work consistent and durable.

A blazed line may disappear in a single season, then who can retrace a *crooked* line through a cultivated field or a field of stumps, and what evidence will there be left to justify you in placing a corner at a distance from the straight line.

It frequently happens that parties contend that their land goes to a certain known line tree, which may be the only one known. A careful survey may show the tree to be several feet from the line. Where the land is hilly and the timber scarce, as in this country, formerly, it was natural to blaze rather crooked trees. The compassman, after getting a sight across a wooded valley, would make a rush for his object, either across or around, leaving the axeman to blaze his way through as best he could. The blazed trees are designed to assist people in finding the corners. The *corners* and other *noted objects* determine the location of the lines, but I doubt if the blazed lines can be relied upon to determine a corner.

A corner erroneously made could be obliterated and remade, but a blazed line is not so easily moved, yet none the more reliable for that. I was lately hunting in a deep ravine for the quarter post upon an east and west line. There were plenty of genuine line trees, but so far out of line that taking what I could see each side of the corner it would be difficult to determine the true position of the corner within 50 links. At last, however, I found the corner, then good bye to crooked blazed lines, for I agree with "T. H." that the official plat shows but a single straight line, which is the identical line the surveyor had in his mind, and tried to mark upon the ground. I fully agree with your summing up in the survey of Sec. 6 (page 104), even to intermediate corners, and straight line subdivisions of sections; yet upon the latter point I think there is considerable to be said that has not yet appeared in your columns, J. B.

PORTLAND, OREGON, Aug. 15, 1875.

MR. EDITOR:

I do not agree with one of your correspondents, who thinks that a post set for the middle of a section can be changed after it has once been established, by proper intersection of the lines between the opposite quarter posts, even if it be found by the transit, after removing the timber, for example, that it was not put exactly where it belonged. I never move corners established and recorded by my predecessors.

I would like to have your views on that point.

Is the line of no variation, or the magnetic meridian, moving east or west at the present time? What is the variation at Chicago now, and what was it 20 years ago?

The public surveys were made in this part of the State about 1853.

An examination of the notes of surveys made at that time, shows the variation to have averaged about 19° east. When I came to the State, in 1861, I found it to be about 20° east, and at the present time it is nearly 22° east, showing an annual increase of about 8′. Within two miles of where I am now writing, there are places where the variation is only 18° east, while in another it is 30° east. It shows how little dependence can be place upon the needle. My observations show that the variation changes less when running north and south lines than it does when running east and west. Is that general, or does it apply only in this locality? C. W. B.

ANS.—As to the changing of corners set by previous survey, we would be governed by circumstances, with a strong inclination to "let well enough alone."

The variation marked on the section lines in this vicinity, run 30 years ago, is 5° E.; the variation now is 6° 30′ E. to 7° E., although in some of the townships immediately north the variation is about 4° 40′ East. We have not noted the differences of the variation on the east and west, and the north and south lines.

WONEWOC, WIS., Feb'y 22, 1875.

MR. EDITOR:

"B. F. D." asks, in the February number, whether I think "*North* from a given section corner means along the section line 'duly run, marked, and returned' by the Gov't Surveyor."

I answer: "No, I do not think so." In fact, I know it don't. The term "North," as a point of compass, has but one signification. It has been decided by the courts that the terms "*due north,*" "*north,*" "*northerly,*" and "*northward,*" mean in the direction of the *true meridian;* and that under either of these calls the boundary line must be run *due north, unless controlled by fixed monuments.*

But the question as to what land is really conveyed in a given deed, where the call is controlled by monuments, is not a question as to the meaning of a point of compass. If "B. F. D." had asked whether I thought that "N. 50° E. from a given section corner," 10 chains, to a white ash tree, meant N. 52° E., because the latter has been shown to be the true bearing between the section corner and the tree, I should answer him in the same manner. The tree would control *that boundary line,* but it would not change the cardinal points of the universe.

Just so with "B. F. D.'s" section line "duly run, marked, and returned." That line may run 5° W. and still, by law, be the proper boundary between the sections lying on each side; and a call in a deed:—"commencing at said sec. cor., thence north 10 chs." (if the land intended to be conveyed were shown to lie wholly in one section), would no doubt be held to convey only to said section line. But said line would not be a north and south line; it would be a line running N. 5° W. and S. 5° E. The north pole could not possibly be moved to accommodate the mistake made in running said section line.

Respectfully, HIRAM W. BARNEY.

CHICAGO, SEPT. 9th, 1875

MR. EDITOR.

My attention has been drawn to the letter signed J. F. Lockport, N. Y. published in your issue of July 15th last.

It seemed to me that the owner of the Lot referred to in that letter is entitled to extend his dock on the lines *a b, a′ b′.* As I understand the law, the owner of the Lot is the owner of the bed of the river *usque filum aqua,* or to the middle of the river, subject to the public right of a passage on the water for boat and navigable purposes. The owner must not make such use of his rights as to obstruct navigation. I submit therefore that, subject to this restriction, he can extend the limits of his lot into the bed of the river for 100 feet, as that would seem to leave ample room for navigable purposes. The law is the same in Illinois as in New York on this subject. The leading case in New York is Canal Appraisers *v.* The People, 17 Wendell, 571; in Illinois, Middleton *v.* Pritchard, 3 Scammon, 510. In Iowa the courts have decided that owners of land on the Mississippi can only claim to high or low water mark. I believe that is the only Western State where such is the law.

Yours respectfully,

JOHN DUNN,
58 Michigan ave., Chicago

Subdivision of "Section 6."

SHAWANO, WIS., July 31, 1875.

EDITOR ENGINEERING NEWS:

I consider that the queries of F. H., on page 58, Vol II., are among the most interesting and important to Surveyors and land owners, which have yet appeared in the NEWS.

For the benefit of the profession I would like to see an earnest discussion elicited between the adherents of pro rata measurements, and those surveyors who always invariably plant quarter-quarter posts upon the boundaries of fractional sections at a distance of twenty chains, non pro rata measurement.

I know that many surveyors have adopted the latter method invariably, and it would be interesting to know the reason why the method has been adopted.

Pro rata measurements are required by the Laws of the State of Wisconsin, by the Instructions of the Commissioners of the General Land Office, and also by Hawes' Manual of U. S. Surveys; and the same has been adopted by a very large majority of the profession throughout the public land States.

For convenience I have inserted in my field book the following rule for pro rata measurements.

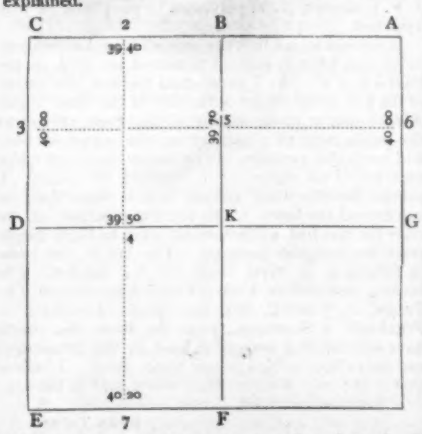
RULE.—As the *recorded* Government distance of the entire line between known Gov. corners : is to the actual distance (U. S. Standard) of the entire line : : so is the *recorded* Gov. length of any lot upon the line : to the required length of the same; the rule is applied in all cases where pro rata measurements may be required.

I have also adopted the following rule of proportion for finding the legal position of the quarter-quarter posts upon the fractional quarter lines of the N. and W. tiers of sections, in cases where the exterior quarter post is not upon a straight section line.

RULE.—As the mean distance (U. S. Standard) of the sum of the entire lengths of the opposite fractional boundaries of the section, between known Gov. corners : is to the actual distance between the centre quarter post and exterior quarter post : : so is the mean distance of the sum of the opposite lengths (upon the section boundaries) of any lots upon the fractional quarter line : to the required length of the same; in its application to Sec. 6, in cases where the N. or W. half of the section is either much less or greater than forty chains, a proportionate mean distance must be adopted in lieu of the mean distance. In all other cases where the quarter line is near the middle of the section, the rule is reliable.

In practice I have always adopted exactly the same principle in the subdivision of the N. and W. tiers of sections, which is required by the U. S. Laws in the subdivision of whole or full sections.

The mode of operation, in answer to its first and second queries, I will demonstrate by the aid of the following diagram of Sec. 6. The data of the diagram furnished by T. H being insufficient for a practical solution, I have supplied the requisite supposed Gov. lengths of the E. and S. fractional boundaries in order that the subject might be clearly and properly explained.



The quarter-quarter posts, 2, 3, 6, and 7, should be established at a distance of 20 chains from B, D, G, and F, in accordance with the Gov. plat; and in all cases where there is either an excess or deficiency, a pro rata measurement must be adopted according to the foregoing rule. We will take first the simplest problem for a demonstration, e. g., suppose that D C measures 40.50 chains, then as 40. : 40.50 : : 20. : 20.25 chs.=D 3 or C 3. Suppose that C B measures 39.30 chs., then as 39.40 : 39.30 : : 20. : 19.94 92-100=B_2; as 39 40 : 39.30 : : 19.40 : 19.35 08-100=C_2.

The quarter-quarter posts 4 and 5 should be set in accordance with the foregoing rule of proportion for interior quarter-quarter posts upon fractional quarter lines, in all cases where the exterior quarter post is not upon a straight section line, e. g., for post 5; the mean of A G+C D=40. chs. as 40. : 39.70 : : 20. : 19.85=B 5 or K 5. For post 4; the mean of C B+E F=39.80 chs.; then find the mean for K 4, thus, B 2+F 7=20 chs.; then as 39.80 : 39.50 : : 20. : 19.84 92-100=K 4; the mean for D 4 is produced by the same method, thus C 2+E 7=19.80 chs.; then as 39.80 : 39.50 : : 19.80 : 19 65 08-100=D 4; proof, D 4+K 4=D K.

In reply to the third query I would say that B should receive exactly "according to the Government survey," although the words are not expressed, yet they are undoubtedly implied; and we know that it is the Gov. survey referred to, unless otherwise expressed; and the case is the same as in the omission in a deed of conveyance of the usual words "more or less."

It is immaterial whether the latter is expressed in any deed, as they are always implied if not expressed, for the simple reason that it is impossible to make a perfect measurement, however short it may be; consequently the contents are liable to be "more or less" in every case, according to the length of chain used, as well as in the skill displayed in its use. Therefore these usual insertions, "according to the Government survey," and "more or less," in a deed of conveyance, are superfluous, and may be either used or omitted at the option of the conveyancer.

The act of Congress of Feb. 11, 1805, contains a wise provision, that the contents of a "section or subdivision of a section," shall be held to contain the "exact quantity expressed" upon the official plat, and it is immaterial upon a re-survey and subdivision, whether there exists either an excess or deficiency.

It is noticed, with regret, that there exists on the part of a few surveyors a marked disposition to correct the Government work, each practising different methods in the subdivision of sections, without due regard to the existing U. S. Laws governing the same, and then defiantly asserting that they will not change their particular methods of subdividing sections, unless demanded by a decision of a Supreme Court.

As for my part I prefer to be governed by the existing laws as expounded by a large majority of the practical engineers and surveyors of the public land States, until the acts of Congress are differently defined by a decision of a Supreme Court.

In reply to the State Line question of E. O., page 93, Vol. II, I would say that inasmuch as the Gov. corners must stand wherever we find them, whether right or wrong, and that the U. S. Law requires straight lines between known Gov. corners in all other cases, I will venture my opinion that the latter method suggested by E. O., is the legal method. I have practised that method in parallel cases upon township lines in this county (Shawano) where there are double corners, the closing corners being in no case established upon the original straight township line.

Very respectfully,

J. M., Co. Surveyor.

BOSTON, Aug. 13, 1875.

MR. EDITOR:

Can some of your readers give me some information on the following point:—In making a model in *papier mache*, of a piece of land on a horizontal scale of say 100 ft. to an inch, if the vertical scale is taken the same as the horizontal, that is, showing exactly the relative situation of each part, the model will look very much flatter than the actual ground appears. But on the contrary, if the vertical scale be much exaggerated, as, for instance, to 5 ft. to an inch, the model would manifestly be an unfair representation of the ground. Now, what I want to know is, what formula or rule can I use in exaggerating the vertical so that the model will appear to correspond in the different parts to the same points on the ground?

Very truly yours, X.

ANS.—Make the vertical scale four times the horizontal.

European Demand for American Engineering Instruments.

Messrs. Heller & Brightly, the Mathematical Instrument Makers of Philadelphia, have recently received and are now filling heavy orders for Engineering Instruments (Transits and Levels) from Vienna, Germany, and from Bristol, England. When it is recalled to mind that up to within a comparatively recent date all the most accurate instruments of this class have been imported from Europe, and that this is the first instance known where instruments of this class have been imported into Germany from this country, this fact is deemed worthy of notice. Messrs. Heller & Brightly are also now filling orders for Engineers' Transits and Levels, etc., for the Imperial College (Kaga Yashiki), Tokio, Japan, from Yokohama and Kokaido, Japan, and Hong Kong, China. They also have recently shipped a number of their instruments to Meigs, of South America, and have present orders for their instruments from Conception, Chili, Havana, Cuba, Nacupai, Venezuela, and the Chimbote R. R., Peru. Neither do our City Engineers go abroad for their instruments, as the Centennial grounds and buildings the Geological Survey of the State of Pennsylvania (now in process), the new Girard Avenue, Fairmount and South Street bridges, and the Leage Island Navy Yard, are all being laid out by means of Instruments made by this firm.

How Inventions are Made.

The life of George Stephenson proves that notwithstanding the novelty and great importance of his improvements in steam transit, he did not discover these improvements. He did not discover that a floating embankment would carry a railway across Chat Moss, neither did he discover that the friction between the wheels of a locomotive and the rails would enable a train to be drawn by tractive power alone. Everything connected with his history shows that all his improvements were founded on a method of reasoning from principle, and generally inductively; to say that he "discovered" our railway system, according to the ordinary construction of the term, would be to detract from his hard and well-earned reputation, and and place him among a class of fortunate schemers who can claim no place in the history of legitimate engineering.

Count Rumford did not by chance develope the philosophy of forces upon which

we may say the whole science of dynamics rests; he set out upon a methodical plan, to demonstrate conceptions that were readdy matured in his mind, and to verify principles which he had assumed by inductive reasoning.

The greater part of really great and substantial improvements which have performed any considerable part in developing modern Mechanical engineering have come through this course of first dealing with primary principles, instead of groping about blindty after Mechanical expedients; and present circumstances point to a time not far distant when chance discovery will quite disappear.

Driving of Piles to resist the force of Ice.

*In Canada and the United States timber is extensively employed as a material of construction, and in many important, as well as minor works, supercedes masonry.

Notwithstanding the appearance of instability and roughness which public works on the continent of America usually present, and which contrasts unfavorably with the highly-finished structures in Great Britain, so much is being done, and remains to be done in America in opening up new territory, and in providing for the increasing wants of the older States and Provinces, that expedition and economy in construction are of paramount importance. Timber piles, where abundant, suitable, and comparatively cheap, supply these requirements better than any other mode of construction; hence piles are found supporting important structures along public roads, railways, navigable rivers, and in harbors.

It is generally the care of the constructors to drive piles only so far that they shall be able to support a specified superincumbent weight, without penetrating the ground further; but in Canada and in the Northern States of America an element of destruction, which has no existence in temperate climates, has to be guarded against. During the severe winters those countries invariable experience, the ice attains a maximum thickness on the approach of spring. As the sun reaches a greater altitude, and the snow melts, the rivers become swollen, pressing the ice upwards. Under such circumstances, if piles enclosed by ice have not a sufficient hold in the ground to withstand the great pressure brought to bear on them, they must be lifted with the ice, and the wreck of the structure they support will be inevitable.

So far as the Author is aware, the resistance of a pile to the action of a specified force applied in drawing it from the ground has never been investigated. The question is apparently capable of solution at least so far as to give the constructor some knowledge of the value of his work. It can at best be but approximate, for the adhesion of ice to timber varies, within certain limits, with the temperature, and piles do not, under all circumstances, hold the ground with equal tenacity. In tidal harbors the ice is not at rest for a sufficient length of time to produce an effect of this kind on piles; but it is very different in the harbors on the great lakes, where thick ice is formed. A storm raises the level of the water in harbors on a lee shore, and as the ice in them may not have been subjected to disturbing influence for weeks, it adheres with great tenacity to the piles, especially when the temperature is low, and occasionally draws them from the ground. Rivers above tidal influence, unless confined by dams for the use of mills, are only affected by a rise of temperature, when the melting snow causes floods that lift the ice. When the temperature is below the freezing point, the adhesion of ice to timber is equal to its cohesion. This may be observed where the level of a body of water dammed back is subject to an occasional rise and fall; if a rise in the height of the water is caused by an increase of temperature, the ice becomes detached from the pile; but should a change take place in the level of the water when the temperature is below the freezing point, the ice generally breaks around the pile at a short distance, leaving a ring of ice adhering to it.

The force that can be exerted by ice on any one pile, may be readily ascertained, if the thickness of the ice and its adhesive power to timber are known. In the early part of the year 1873, the Author made eight experiments, which gave a mean result of 29 43 lbs. per sq. in. as the adhesion of ice to timber.

With regard to the driving of piles to enable them to resist a force tending to draw them from the ground, the elements avaliable for calculations are—the weight of the ram, the space it falls through, and the space through which the pile is driven by the blow. Professor Rankine gives a formula for calculating the effective resistance of the ground to the penetration of the pile, which includes the modulus of elasticity of the pile, and involves the solution of a quadratic equation. This formula has no value for practical men, who require something simple, and of easy application. So long as a pile is able to penetrate the ground, it is evident that the more dense the medium through which it passes, the greater will be the pressure on its sides, and consequently the greater the force required to draw it. At the same time, the more compact the ground, the greater resistance it offers to the penetration of the pile. Hence any formula founded on the above data is valueless when a pile, on being driven; meets with an impenetrable obstruction.

With a view to throw light on this subject, the Author made series of experiments from which it would appear that it is practicable to drive piles so as to effectually resist the action of a specified force tending to draw them from the ground. Those experiments indicate that the force capable of drawing a pile is directly as the weight of the ram employed in driving it, and the space through which the ram acts; and inversely as the distance the pile is driven by the blow and the circumference of perimeter of the cross section of the pile. From this data a co-efficient has been deduced, mean of forty experiments giving ·3285 as the value.

Let W = the weight in lbs. of the ram.
F = the space in inches through which it falls.
s = the distance in inches to which the pile is driven by the blow.
R = the force in pounds required to draw the pile.
p = the perimeter or girth of the pile in inches.
C = the co-efficient.

Then,

$$\frac{R \times s}{W \times F} \times \frac{p}{4} = \frac{R \times s \times .25\, p}{W \times F} = C \quad . \quad . \quad (1)$$

As a pile 1 inch square has a perimeter of 4 inches, $\frac{p}{4}$ appears in formula.

$$\frac{W \times F \times C}{.25\, p \times s} = R \quad . \quad . \quad . \quad (2)$$

$$\frac{W \times F \times C}{.25\, p \times R} = s \quad . \quad . \quad . \quad (3)$$

In formula (3) R may represent the force which a given thickness of ice is capable of exerting, and any excess of that force which it may be considered necessary to allow for safety. These formulæ are simple, and although, no doubt, only approximate, still in practice they are likely to give results quite as satisfactory as any adaptation of Professor Rankine's more theoretical formula.

*A Paper read before the Institution of Civil Engineers, by J. W. James, M. Inst. C. E.

The experiments would have been more conclusive if extended to larger piles and more powerful machinery, but as the Author could not readily procure assistance, he found it impossible to carry out the experiments to the extent he wished. From observation of works erected on piles driven by a ram whose weight and the space through which it acted were both known; and the distance a pile was driven by the last blow, as alleged by the foreman of the work, the Author is confident that the formula possesses some value when applied to piles of larger dimensions.

He had an opportunity, during the first three months of the year 1873, of observing the action of ice on the piles of a bridge, constructed during the previous year, across a river confined by a dam for the use of mills. The piles had been driven by a ram of 940 lbs. in weight, the space through which it acted was approximately 20 feet, and the piles were driven until the penetration declined to one-half inch under each blow. The level of the water changed frequently, during the three months, to the extent of 1 foot to 2 ft. The piles held their ground, and the ice broke away until it had attained a thickness of from 15 to 16 inches, when the piles began to come up. Some held the ground until the ice had gained several additional inches in thickness, but eventually all yielded to the superior power of the ice, and the bridge became a wreck. The piles were about 12 inches in diameter. The force that the ice could exert on such a pile would be equal to the circumference of the pile multiplied by the thickness of the ice, and by the adhesion per square inch of ice to timber. As the temperature was very low at the time the piles were drawn up, the adhesion cannot be safely taken at less than the mean of five experiments marked "Freezing" in the table of experiments on ice in Appendix, page 13. The mean value of the adhesion is 33·32 lbs. per sq in.; then $37{\cdot}7 \times 15 \times 33\frac{1}{4} = 18{,}850$ lbs. And from the formula

$$\frac{W \times F \times C}{{\cdot}25\, p \times s} = \frac{840 \times 240 \times {\cdot}33}{{\cdot}25 \times 37{\cdot}7 \times {\cdot}5} = 15{,}806 \text{ lbs.},$$

is the force capable of drawing the pile; but the weight of superstructure resting on each pile, about 3,000, lbs., should be added, which would make the force required to draw the pile equal to 18,806 lbs. Had the space through which the ram acted been ascertained with greater accuracy, this illustration of the formula would have been more satisfactory; but the driver was worked, on the ice, and equal lengths of the piles did not project above its surface when the last blow was delivered, so that the space described by the ram was in some instances, greater, and in others less, than 20 feet.

If the mean pressure of the ground on the sides of a pile were constant, it might be relied on as a simple datum for calculation; but it will be perceived by comparing the mean pressures shown in the tables of experiment, with the distance the piles were driven by the last blow, that the more dense the soil the greater was the pressure on the sides of the pile. The intensities of those pressures will vary from causes which cannot always be perceived; for instance, should a pile be clasped tightly between large boulders the mean pressure will be considerably increased; but should the point of the pile get broken or crushed in driving, the mean pressure on its sides may be much less than that found by the experiments, which is nearly 18 lbs. per sq. in. As the adhesion of ice to timber appears to be about four times as great as the mean pressure of the ground, for equal areas, it may be assumed that the pile should be driven more than four times the maximum thickness of the ice.

The pressure per square inch on the point of a pile, is no doubt greater than the mean pressure on its sides. It was ascertained, when drawing the piles, that after they had been lifted from 1 inch to 2 inches, and the points released, the mean pressure per square inch on their sides, was about 3 lbs. less than when the point held the ground. The points of all the piles experimented on were four sided, and in length were equal to twice the diameter of the pile. Points more taper than this should penetrate the ground with greater ease, and consequently should give a higher co-efficient; but they are weaker and more liable to injury than those employed in making the experiments, and cannot be considered of such general application. In ten of the experiments the points were wedge-shaped, the edge of the wedge being equal to half the diameter of the pile. As such points present a greater surface to the ground, where the pressure is most intense, it was expected that they would afford better results than those whose sides tapered equally to a sharp point, but the experiments do not show that they possess any advantage.

The experiments on ice were made when the temperature was from 10 to 12° below the freezing point. This was likely to give more satisfactory result with small piles than if the frost had been more intense, and the ice of greater thickness. The piles were suspended in a tub of water in the evening in an open shed, and allowed to remain until the morning, when they were forced through the ice with a level care fully weighted; they were so suspended that several inches of their length protected below the under surface of the ice, which adhered to their sides only.

A coating of coal tar on the piles would cause them to absorb and radiate heat more rapidly, and thus assist in weakening the adhersion of ice without adding much to the cost of the structure; this would certainly be of value on the approach of spring, as at this season the ice has attained a maximum thickness, and piles which have resisted its influence up to that time, are then frequently drawn out of the ground.

The Third Annual Exhibition of the Inter-State Exposition, of Chicago, opened on Sept. 8th, and will close October 9th. The exhibit in all the sections is much finer this year than either of the previous ones, and not withstanding the continuance of "hard times" its complete success, financially and otherwise, seems assured. In the Fine Art Department, home talent is on exhibition principally, and is a feature not hertofore very prominent. The scientific Department is also notably excellent, the Academy of Sciences having taken an interest in the matter, and lent its aid, while in the Mechanical Department the manufacturing interests of the Northwest are well represented. The immense building on the lake shore is now the great local attraction of Chicago, and is daily thronged with sightseers from all parts of this and adjoining States.

CIVIL ENGINEERS' CLUB

Of the Northwest.

E. S. CHESBROUGH, President.

L. P. MOREHOUSE, Secretary.

S. S. GREELEY, W. M. R. FRENCH, } Executive Committee.

CHICAGO, September 15, 1875.

The October Meeting of the Club will be held at the Sherman House Club Room, on Tuesday, Oct. 5th, beginning at 4.30 P. M.

Mr. I. C. CHESBROUGH will read a paper, (No. 55), on "THE ALBANY WATER WORKS."

The attention of Members is called to the fact that *Card Notices* will not hereafter be sent, but that notices will be published in the ENGINEERING NEWS, a copy of which will be mailed to each Member.

Attention is also called to the *Card* enclosed with the notice of the September meeting. Some members have not yet responded.

L. P. MOREHOUSE, Secretary.

The Goose Quill Business as applied to Water Works Six Hundred Years Ago.

[A paper read before the Civil Engineers' Club of the Northwest, Sept. 7, 1875, by Wm. Bryson, Asst Engineer Board of Public Works, Chicago.

The citizens of Dublin had an acqueduct to supply the city with water, from which it was conveyed by pipes to the houses, so early as the thirteenth century—a very singular fact, especially when we consider the state of many cities, where the only way of obtaining water was to buy it in the streets.

In an ancient and curious book in the possession of the corporation of the city of Dublin, called the "Domesday Boke of Dyvelyn City," is the following entry:

"De receptione aqueductus prioratu Sanctae Trinitatis Mem. Quod in crastino Sancti Leonardi Confessoris anno regni regis Henrici XXXIX., Prior Sanctæ Trinitatis Dublin, et ejusdem loci Conventus, receperunt Aquam De Vase civium dictæ civitatis Dublin. Quod quidem vas assistitur ex opposito theolonis civitatis juxta portam Sanctæ Trinitatis duratur a dicto die usque ad finem trium annorum proxima sequentium."

Translated, Memorandum. That on the morrow of St. Leonard, in the 39th year of King Henry (Nov. 7, 1239), the Prior and Covent of the Holy Trinity of Dublin, received the Water from the Vase (basin or reservoir), of the citizens of the said city of Dublin; that is the vase situated opposite the Tholsel of the said city, and near the gate of the Holy Trinity. To be held by them for the three next following years from the said day."

It would appear by this and the following entries, that there were basins or reservoirs for the reception of the water in various quarters of the city, from which the inhabitants could have pipes laid on to supply their houses.

The article immediately preceding the Memorandum, is a grant from the citizens of Dublin to the Abbot and Convent of St. Thomas, of certain lands juxta aquaeductum, which is witnessed by Gilbert de Lynet, who was the first Mayor of Dublin, in the year 1228, and the grant is by the *citizens*, and not the *Mayor and citiscns*, as was the case after that period; this grant, which is without date, must have taken place before that year. The witnesses are Audeon Brown, John de St. John, Gilbert Lynet, and others. How long before, the acqueduct existed does not appear.

A second entry occurs as follows:—

Memorandum. That on Thursday, after the feast of St, Petronella, in the 39th year of King Henry III., a deed made between the Mayor and inhabitants of Dublin, on one part, and the Prior and Convent of the Holy Trinity on the other, respecting the City Acqueduct. The copy of the Prior is deposited for safe keeping with Friar Cradoc, of the Hospital of St. John the Baptist; and the copy of the City with Thomas Ruffe, the Provost of the City.

A memorandum is entered on page 48, of the same book, to the following effect:

Of Rents Granted to the pipe—

Memorandum. That those underwritten gave to *the support of the pipe* of Dublin, the following rents for ever: William of Chester gave 11s. annual rent out of his house on the banks of the Liffey; William Pycot gave 12d. out of the stone house which belonged to William Sweetman; Alexander de Ultonia gave 12d. annual rent out of certain lands in Potter street (In vico Figulorum), with the arrears.

In page 51, is an entry of a grant of a certain part of the acqueduct, from the Mayor and commons, to the Abbot and Convent of the Friar's Preachers in perpetual alms, beginning within the walls at the New Gate, near the house of William Clark and allowing the said Friars to join their pipe to the citizens pipe, with a free transit of the said pipe through the land of the citizens to their house, provided that the pipe, where it joined the house, should not be so large that the little finger of a man could be inserted, and that it should never be made larger. This deed is witnessed by Luke, Archbishop of Dublin, who died in 1255.

1287. 16 Edw. I. The Mayor, &c., granted to Sir Richard de Exeter, (afterwards Dexter), a certain portion of water, that is of a pipe equal to the size of a goose quill, and also to their fellow citizen Henry C. Marshall, for the convenience of himself and his neighbors dwelling near him; that he should be allowed, at his own expense, to attach a pipe to theirs, near the corner which led to Kilmaholmok's street, to conduct the water to his house, near the church of the Holy Trinity, into his cistern or reservoir; but the pipe not to exceed the grossness of a goose quill.

1342. This year is a grant to Master Walter de Istelep, of right to affix a pipe of the size of a goose quill, to the cistern in High street, near St. Michael's Church, at 6d. per annum, during his life and his heirs, and afterwards to pay 2s. at two terms, Easter and Michaelmas.

1329. 3 Edw, III. A grant to Nicholas Fastolf, and Cecilia, his wife, that they might have a pipe from the cistern of Master Walter de Istelep, in the parish of St. Nicholas, to their house, to be carried along the middle of Rochelis street, not to exceed the size of a goose quill.

Extract from "The Annals of Ireland:"

"1308. This year a marble cistern was made to receive the water from the conduit head in Dublin, such as was never before seen here), by the Mayor of the City, Master John Le Decer, and all at his own expense."

This John Le Decer filled the office of the Mayor of the City in the years 1308, 1309, and 1324.

Thus early did the anxiety to possess a supply of wholesome water for the citizens of Dublin, induce ingenious and patriotic individuals to suggest, and the corporation to adopt and execute, a plan for an artificial acqueduct for that important purpose, how long previously to the reign of Henry II, is not known, but it certainly has existed six hundred years. The proximity of the mountainous district to Dublin gives facilities to such an undertaking. The minute particularization that the pipe should not exceed the size of a goose quill, indicates that it was always flowing, and the value put upon it.

Familiar as the last half century has made us with vast economical erections, we cannot look back to the acqueducts of the ancients—those stupendous tiers of arches upon which they conducted their supplies of water across valleys and rivers—without regarding them with curious interest. Though remains of acqueducts, or water courses, are yet to be discerned in Syria, Persia, and other eastern countries, it was only among the Romans that the construction of such works was carried to true magnificence and perfection, and this not only for the supply of their own capital, but also for the benefit of the chief towns to their subject provinces. The acqueducts of Rome extended thirty, forty, and even sixty miles from the city, in one continued covered channel of stone, carried by arcades over the deepest and widest valleys, and by tunnels, running in many parts for miles through mountains, and through the solid rock. Frontinus, who was curator of water works under the emperor Nerva, mentions nine aqueducts by which the city was supplied; five more were added by Nerva; and the number was afterwards augmented by succeeding emperors to twenty. In one part the New Anio is said to have extended six miles and a half in one continued series of arches, many of them upwards of 100 feet high. The Aqua Martia, which owed its formation to Quintus Martius, rose from a spring thirty-three miles distant from Rome, made circuit of miles, and afterwards forming a vault of 16 feet in diameter, it ran for thirty-eight miles along a series of arcades at an elevation of 70 feet, makin all not fewer than 7000 arches; the Aqua Julia and the Aqua Tepula were brought to Rome by the same aqueduct as the Aqua Martia, but on higher levels. The whole aqueduct above the arcades was divided into three stories or channels. In the uppermost flowed the Aqua Julia, in the second the Aqua Tepula, and in the lowest the Aqua Martia. From the ruins of this combined fabric which still exist, it appears to have been a very superb structure, The Aqua Claudia—began by Nero and completed by Claudius—took its rise thirty-eight miles from the city. It formed a subterranean stream thirty-six miles and and a quarter in length, ran ten miles and three quarters along the surface of the ground, was vaulted for the space of three miles, and supported on arcades through a space of seven miles, being carried along as high a level as to supply the hills of Rome. It still continues to furnish the modern city with water of the best quality, which has hence procured it the present name of Aqua Felice;

Of the provincial aqueducts which still remain as relics of Roman grandeur, the most remarable are the aqueducts of Metz, the aqueduct of Nismes, or the Pont du Gard, and that of Segovia in Spain. The former is now greatly dilapidated; but there still remain a great number of arches, and enough to give an idea of the whole. It extended across the Moselle—a very considerable river, and very broad in this place—and served to convey the delicious waters of the Gorse to the city of Metz. These waters are said to have been sufficiently abundant to float vessels every time that a naval fight was to be exhibited. They were carried across the Moselle by means of the aqueduct, which was situated about six miles from Metz, and

from thence were conducted under ground, in stone channels similar to the others, to the city, to the baths, to the place of the sea fight, and for the use of the inhabitants. This aqueduct seems to have been about 1000 feet in length, the arches 50 feet high at the deepest part, and fifty in number. The Pont du Gard—that part of the aqueduct of Nismes which crosses the the deep valley in which the Gardon flows—was executed in the reign of Augustus, and is one of the noblest remains of Roman architecture among the Gauls. It is composed of three ranges of arches, one above another. The first row comprehends six arches, each 60 feet span; excepting one which was the largest, and was 75 feet span, the second row contained twelve arches of the same span as those of the first; and the third had thirty-six little arches, on the top of which was the channel for conducting the water. The total height of the structure above the water of the river was 160 feet, and its length 300 yards. This structure though destroyed in the fifth century, was still in such a state of preservation in 1740, as to be converted into a roadway by widening it, or rather by building in a manner another bridge to the side of it, having all the arches of the same span and dimensions. Of the aqueduct of Segovia, there still remain 159 arches, all built of large stones, and without any cement. There are two tiers, and the entire height of the edifice is 102 feet.

The great acqueduct of Spoleto, constructed in the year 741, by Theodoric, king of the Goths, to communicate with the town of Spoleto remains entire to the present day. In crossing the river De La Morgia, the channel way is supported upon two tiers of arches, the lower containing ten, and the upper thirty. The length of the arcade is 800 feet, the breadth 44, and the height 420. The aqueduct of Caserta, built in 1753 by Charles III. of Naples is also a gigantic structure, one of its arcades consisting of three tiers of arches 1724 feet long, and 190 feet in height. That of Lisbon, completed in 1738, is also no mean structure. It is about three leagues in length, and in some parts of its course has been excavated through hills; but near the city it is carried over a deep valley for a length of 2,400 feet by several arches, the largest of which has a height of 250 feet, and a span of 115. Of the modern aqueducts in France, that which conducts the waters of St. Clements and Du Boulidou to Montpellier is perhaps the most beautiful. It was built under the superintendence of M. Pilot, and required thirteen years for its completion. The principal arcade is 90 feet high, and consists of two tiers—the lowest containing ninety, and the upper two hundred and ten arches.

The Croton aqueduct conveys the water of the Croton river, for a distance of thirty- eight miles, to the city of New York. This aqueduct was finished in 1842, and was capable at this date of discharging sixty millions of gallons in twenty-four hours. The chief arcade in its course is that of Harlem, which consists of fifteen arches; seven of which are 50 feet span, and eight of 80 feet, the greatest height being 150 feet from the foundation.

'Tis to the Press and Pen we Mortals owe,
All we believe, and almost all we know,
My Goose Quill now has ceased to flow.

Minutes of the September Meeting of the Civil Engineers' Club of the Northwest.

The 58th regular meeting of the Civil Engineers' Club of the Northwest, was held at the Sherman House Club Rooms, Tuesday, September 7th, 1875, beginning at 4.30 P. M.

Minutes of the last meeting were approved; having been printed the reading of them was omitted.

Messrs H. W. S. Cleveland and L. P. Morehouse proposed Jas. R. Willett, of Chicago, for membership.

The Executive Committee and the Secretary, appointed as a special committee to report concerning a Library, submitted a report recommending an appropriation for the purchase of books. The Executive Committee, in the same report, recommended that a change be made in the place for holding the monthly meetings, and also that an arrangement be made with the Proprietor of ENGINEERING NEWS for the publication of the Club Papers and Proceedings.

Upon motion, the Report was accepted.

The following Resolution, after discussion, was passed:

Resolved, That from the amount of dues now in process of collection, two hundred dollars be, and are hereby appropriated for books.

Pending the discussion concerning a change of rooms, the Secretary stated that there was a misunderstanding between the officers of the Chicago Chapter of the Society of American Architects, and the officers of this Club, in relation to the time for which the lease of rooms occupied last year had been made.

By resolution, the Secretary was directed to arrange the matter on such terms as should be found satisfactory to the Architect's Society and to himself, as the representative of the Club.

It was further *Resolved*, That until further action on the subject, the meeting of the Club be held in the Sherman House Club Room.

After consideration of the question, the following resolution was adopted:

Resolved, That the proposition of Mr. Geo. H. Frost, Proprietor of ENGINEERING NEWS, as made to the Secretary, August 23d 1875, for the publication and printing of Club papers, &c., be, and is hereby, accepted.

The Paper for the evening, No. 54, "The Goose Quill Business, as applied to Water Works Six Hundred Years ago," was then read by Mr. Wm. Bryson, and was followed by the usual discussion.

The Secretary announced the receipt of a document for the Club, from Gen. Humphreys, Chief of Engineers, U. S. A.—Preliminary Report upon a Reconnaissance through Southern and Southeastern Nevada, in 1869.

Mr. W. M. R. French exhibited, with explanations, a large number of heliotypes, from Osgood & Co., printed by the heliotype relief process.

The meeting adjourned to meet at 4.30 P. M., on the 5th of October.

L. P. MOREHOUSE, SECRETARY.

LIST OF MEMBERS OF THE CLUB.

Hugh Baines, Toronto, Ont.
W. L. Baker, C. E. Detroit Bridge and Iron Works, Detroit, Mich.
J. W. Barlow, Col. U. S. A., New London, Conn.
E. L. Billings, C. E., Room 29, Morrison Block, Chicago, Ill.
J. E. Blunt, Ch. Eng. Chicago & Paducah R. R., Wheaton, Ill.
K. F. Booth, Ch. Eng. Chicago & Alton R. R., Chicago, Ill.
E. Lee Brown, Clinton and Jackson sts., Chicago, Ill.
Wm. Bryson, C. E., Board of Public Works, 48 S. Sheldon st., Chicago, Ill.
O. Chanute, Ch. Eng. Erie R'y, New York, N. Y.
E. S. Chesbrough, City Eng., Chicago, Ill.
I. C. Chesbrough, C. E., City Water Works, Albany, N. Y.
E. C. Clarke, C. E., Chicago, Ill.
F. W. Clarke, C. E., 133 La Salle st., Chicago, Ill.
L. H. Clarke, Ch. Eng. I. C. R. R., Chicago, Ill.
W. H. Clarke, Ass't City Engineer, Chicago, Ill.
H. W. S. Cleveland, Landscape Architect, Portland Bl'k, Chicago, Ill.
A. Comstock, C. E., Joliet, Ill.
Lyman E. Cooley, Prof. of Civil Eng., N. W. Univ. Evanston, Ill.
E. L. Corthell, C. E. So. Pass Jetty Co., New Orleans, La.
D. C. Cregier, Ch. Eng. City Water Works, Chicago, Ill.
Chas. Davis, C. E., Allegheny, Pa.
C. W. Durham, C. E., Major Bl'k. Chicago, Ill.
G. H. Ellers, C. E., Box 131, Paterson, N. J.
S. T. Emerson, Ch. Eng. St. L., Ks. C'y & N. R'y,, St. Louis, Mo.
R. E. Farnham, C. E., C. & N. W. R'y., Chicago, Ill.
F. U. Farquhar, Col. U. S. A., St. Paul, Minn.
M. N. Forney, R. R. Gazette, New York, N. Y.
J. F. Foster, C. E., Stock Yards,
W. M. R. French, C. E. and Landscape Architect, Portland Bl'k. Chicago.
G. H. Frost, C. E., Pub'r. Engineering News, 168 Washington st., Chicago.
N. Gleason, C. E., Laporte, Ind.
S. S. Greeley, C. E., Nixon's Building., Chicago, Ill.
O. B. Green, Contractor, La Salle and Water sts,, Chicago, Ill.
Rob't. Harris, Gen. Supt. C., B. & Q. R. R., Chicago, Ill.
Max Hjortsberg, Ch. Eng. C., B. & Q. R. R., Chicago, Ill.
D. C. Houston, Col. U. S. A., Milwaukee, Wis.
C. W. Irish, C. E. Box 291, Iowa City, Iowa.
W. L. B. Jenney, Arch. and C. E., Portland Bl'k, Chicago, Ill.
Walter Katte, City Eng., St. Louis, Mo.
J. H. Kellogg, C. E., Board of Public Works, Chicago, Ill.
T. M. Kellogg, Pontiac, Ill.
Moses Lane, Ch. Eng. City Waterworks, Milwaukee, Wis.
C. Latimer, Ch. Eng. Atlantic & G't. Western R. R., Meadville, Pa.
R. B. Mason, Chicago, Ill.
R. J. McClure, C. E., C., B. & Q. R. R., Chicago, Ill.
W. S. McHarg, C. E., Board of, Public Works, Chicago, Ill.
M. A. A. Meyendorff, Supt. of Construction, U. S. Assay office, Helena, Mon.
C. J. Moore, C. E., 52 Broadway, New York, N. Y.
L. P. Morehouse, Asst. Eng. I. C. R. R., Chicago, Ill.
Geo. C. Morgan, C. E., Major Bl'k, Chicago, Ill.
John Newell, Gen. Man. L. S. & M. S. R'y., 379 Superior st. Chicago, Ill.
R. M. Newman, Jackson, Mich.
T. J. Nicholl, C. E., Hennepin, Ill.
L. J. Olmsted, Ch. Eng. Chicago & So. Atlntic R'y. Delphi, Ind.
A. W. Paige, care Crerar, Adams & Co., Chicago, Ill.
Chas. Paine, Gen. Supt. L. S. & M. S. R'y, Cleveland, Ohio.
O. M. Pope, Gen. U. S. A., Engineer Dept., Washington, D. C.
W. S. Pope, Pres. and Eng. Detroit Bridge and Iron Works, Detroit, Mich.
Richard Potts, C. E., Board of Public Works, Chicago, Ill.
C. J. Quetil, C. E., Box 814, Pittsburgh, Pa.
T. J. Seeley, C. E., Waucoma, Iowa.
F. Slataper, Ch. Eng. Pennsylvania Co., Pittsbuagh, Pa.
Jared A. Smith, Maj. U. S. A., Key West, Fla.
W. S. Smith, C. E., Maynard, Ill. L. Soulerin, Milwaukee, Wis.
J. R. Straughan, C. E., Fort Wayne, Ind.
E. B. Talcott, 606 Wabash Ave., Chicago, Ill.
J. B. Wheeler, Col. U. S. A., Prof. in U.S. Mil'y. Ac'y., West Point, N. Y.
D. J. Whittemore, Ch. Eng. C., M. & St. P. R. R., Milwaukee, Wis.
B. Williams, C. E., Board of Public Works, Chicago, Ill.
E. Williams, C. E., Box 147, Virginia City, Nevada.
W. W. Wright, Leavenworth, Kan.

Consolidation of Earthworks.

BY JULES GAUDARD, CIVIL ENGINEER, LAUSANNE.

Translated from the French by James Dredge, C. E.

[CONCLUDED.]

RESTORING CUTTINGS AFTER LANDSLIPS.

*When a landslip is not very considerable, it is sufficient to raise it completely and promptly, so as not to allow time for fresh slips. The new ground is then properly drained and strengthened by a counterfort.

On the line from London to Birmingham, and on the Croydon railway, some local slips were restored with counterforts in dry stone and gravel. The spaces between counterforts may be made good with rammed earth. On the South-Western railway hard chalk has been successfully employed in the construction of counterforts, instead of gravel.

In the Briel cutting on the Mulhouse railway, a Sazilly drain was made to collect the water. The cavity left by the slip was refaced with a layer of rammed earth, and the lower points of the Sazilly drain were joined with the side ditch of the way by transverse channels. In such cases it may happen that the glacis, M N, of the slip may be below the level of the side ditch; it is then advisable to make it up again with earth carefully rammed (Fig. 31).

Certain slips on the Paris-Coulommiers line required the application on the new ground of two or three tiers of drains, connected with the ditch by transverse drains.

With landslips on a larger scale, the great labor of bodily removing the whole of the fallen material has been sometimes undertaken, the saturated loam being difficult to drain properly, as, for instance, the New Cross cutting on the Croydon railway. But such a course is long and costly, and in many cases the principal part of the fallen earth may be left in place, if care be taken to consolidate it by the construction of drains which shall remain connected with the points of natural outflow. This was done successfully, for example, in the Hundsoff cutting on the Wissembourg railway. An excavation, A B C D (Fig. 32), was made of sufficient extent to lay bare the undisturbed ground, and at the foot an open drain, C, was formed. If the material be very soft this excavation must be timbered, but it is sometimes firm enough to allow of the earth excavated being temporarily thrown up on the top of the slip, as at G. The drain is covered with turf, then a rammed-earth counterfort, B D, is formed, and finally the excavation is filled in again with the earth taken out (G). If the fall of the glacis or water-bearing line is insignificant, it will be sufficient to clear away the portions, E, which have fallen on the way. The masses at the rear will by this time have consolidated sufficiently to remain in place, in spite of the forward parts being removed, and a new face slope is formed, which is covered with 12 inches of rammed earth. The top surface of the slip ought to be evenly dressed, and all cracks and openings stopped up, to prevent the penetrations of rain water. In landslips of considerable length and parallel to the way, it is advisable to form transverse cuttings at intervals, connecting the low points of the drain with the side ditch.

There is no cause for surprise that a bank, which has been little more than a mass of fluent mud, can be preserved without fear if it has been thoroughly dried. The action of water followed by a drying process produces an active compression and cohesion. The only danger to guard against is the return of the work to its original state.

M. Bruere gives in Perdonnet's Noveau Portfeuille (Documents, page 172), details of the drainage of a landslip at Briel. The sides of the slip were first trenched out in successive lengths of 12 or 15 feet, and a drain constructed at the bottom, which was covered by the earth taken out of the next length. When the rear of the slip was reached it was necessary to proceed cautiously, and in 10-feet lengths of well-timbered excavations, for the filter wall. The forward portion was also drained, and supported by an earth counterfort.

It is especially advisable, in cases where the angle of slip is considerable, to prevent the recurrence of such an accident by retaining the ground with a rammed earth-bank, separated from the slip by a filtering wall of broken stones (Fig. 33).

Sometimes the slip hollows out the subsoil, remains more or less charged with water, and tends to fall further upon the road bed. It is then preferable to excavate the upper portion, M N P, Fig. 34, and at the same time the face, N P, is exposed for drainage.

When a slip occurs in ground wherein occur water-bearing seams of considerable extent, it is necessary to effect the drainage by means of gravel filters of large areas. Such a work has been executed on certain parts of the Soultz cutting (Eastern railway of France), where a bank of clay is permeated by water-bearing lines, which, extending for a considerable distance, produce dislocation of the surface. The filter (Fig. 35) which drains the bank, discharges at intervals into a channel formed along the centre of the road bed and to which sufficient fall is given; in the intervals, the filters drain simply into the side ditch. In other portions of the same cutting longitudinal and parallel furrows, separated by banquettes, were formed in uncovered clay. These furrows were protected by stone, and were intersected by discharge drains into the side ditches. The whole was then recovered with good earth, brought down with the slip, the wet loam being carried to spoil.

It is absolutely necessary to deal with landslips with the utmost celerity, in order to prevent their spreading, a casuality which always renders them costly to repair, and sometimes restoration becomes impossible. The works require careful watching for a year or two. To clear away obstructions, to maintain the slopes, to prevent the accumulation of water, to break the ice which in winter stops up the drains, and to preserve and encourage the vegetation of the slopes, are all duties which must be carefully performed. An obstruction of a drain reveals itself by filtration, which appears on the surface of the earth revetment.

CONSOLIDATION OF EMBANKMENTS.

Under the most favorable circumstances newly-excavated embankments of considerable height settle more or less, and this settlement may even continue during several years. Thus it is expedient to raise the profile of the work slightly, it being easy to repack the ballast. Wagon-tipped banks are not so consolidated as those formed with carts, and which are subjected to the tramping of horses. In forming a bank over culverts or other structures (travaux d'art), it is necessary to tip the earth equally on both sides, and to ram it as the work proceeds, in order to avoid throwing a mass on either side, which would produce a dangerous thrust against the masonry.

FIRST CASE. YIELDING FOUNDATIONS.

When the ground of the valley is composed of sliding clay beds, with inclined water seams, the weight of the embankment will set in motion this unstable base, which will sink unequally, or slip in the direction of the transverse slope. In the uncertain soil of Brittany upheavals from 6 feet 6 inches to 14 feet in height are noticed, which spread on each side until they measure from 120 feet to 200 feet in length. Certain soils, peaty from the surface downwards, sink as much under a small as under a large bank. Others, covered with a thin but firm layer, resist for some considerable time heavy but localised pressures; then, when the embankment becomes extended and complete, or when its weight has been sustained during a certain time, a great subsidence suddenly takes place, arising from the rupture of the surface crust, and which soon spreads over the whole extent. Such a rupture occurred, for example, on the Hanwell embankment of the Great Western railway.

Often the best and simplest remedy is to add new material to the embankment as it sinks, until further settlement ceases. Banks of this class in Brittany have thus absorbed two or three times their original volume, and this mode may soon become too costly, if there is not sufficient excess from adjacent work, or an ample quantity within reach. In compact peaty ground

*From the Proceedings of the Institution of Civil Engineers' 1874.

the lower portion A, Fig. 36, assumes the form given in the sketch, without sinking to any great depth, whilst in very soft material the bank may sink bodily to the bed, forcing away the yielding ground on each side. In steep valleys the earth will yield on the lower side and cause the bank to slip.

When the faulty bed of the subsoil is too thick to be passed through or to be removed, two courses are commonly employed to check derangements: to endeavor to improve the nature of the uncertain foundation, and to reduce the pressure exerted on it by the earthwork.

The condition of the subsoil may be sometimes improved by compressing or confining it; for example, by driving a large number of short piles, or by excavations in form of truncated pyramids, filled afterwards with compact clay. This is a German method, an example of which from Hattenhofer, on the Munich-Augsburg line is given in the "Annales Francaises des Ponts et Chaussees," 1845. But generally the true solution consists in draining the subsoil, which, once dried, acquires sufficient solidity. For instance the embankment at Val Fluery (Versailles railway) sank, breaking up the foundation, and as it was not considered safe to raise it again to the necessary level, the difference was made good with trestle work. After the lapse of some years, however, it was resolved to restore the embankment, and two large parallel drains were formed on the lower side (Fig. 37). These drains, from 39 feet to 50 feet in depth, were connected together, and led all the water away in such a manner that the foundation was dried, and was surrounded and maintainded as by a protecting belt.

Between Otzaurte and Oazurza, in the North of Spain, moist valleys are met with, where the soil of clay and marl slips on schistous strata. Several embankments on the northern line yielded at the base, and it became necessary to surround the area on which they stood by a double network of drains; encircling ditches with discharge culverts for the surface water; then for the internal drainage galleries 5 feet high and 39 inches wide were driven along the schist, and cutting into it from 15 inches to 20 inches at least, in order to stop subsequent movement and to drain the sliding surface. These galleries followed the irregularities of the rock in such a manner as to involve slopes of from 1 in 33 to 1 in 17. They were then filled with a mass of broken stone, leaving a space at the top, clear of the fissures which admit the water. Driving such galleries is less likely to bring about land-slips in ground of this nature than open excavations; it should, moreover, be more economical at depths greater than 16 feet.

In order to reduce the weight of an embankment on the foundation, it is necessary to construct it in light materials, and to enlarge the base. The embankment close to Cubsac suspension bridge (Dordogne) was formed with voids in the interior of the mass. The base is increased by reducing the slopes, or, better, by lateral counterforts. Lastly, it is often advisable to construct the bank on a double tier of fascines, placed obliquely and crossing each other. These form an elastic bed, light, and able to drain the superimposed mass; and they prevent partial and unequal settlement by dividing the load more uniformly over the foundation. This was done, for example, on the Beaucaire canal. The Chatmoss (Liverpool and Manchester railway) bank is formed of light materials, and rests on a system of fascines.

SECOND CASE. SLIDING EMBANKMENTS.

Embankments are sometimes executed in bad material, such as clay more or less charged with water, or which is easily saturated by rain, or where the earth has been greatly disturbed, and thus absorbs water more freely then in its natural state. Then the rapidity of execution so frequently required, is a fertile cause of bad construction; work is carried on, despite inclement weather, and mud or frozen earth is tipped on the band without hesitation. The employment of large earth wagons is also objectionable, because the material in falling assumes its natural slope, and tends to produce stratification. This is especially the case when the bank has a hearting, N, Fig. 38, formed with end-tipping wagons, while the side portions completed by side-tipping, Besides the inequalities inseparable from constructing portions of the embankment at different times, and often with different materials, it may happen that sand, or even mud, may have been thrown on the line of junction *a b*, which produces a stratum of leakage, coincident with the natural slope. There can be no cause for astonishment, therefore, if the outer part of the bank falls in the direction *a c d*.

There are many prudent measures which should be adopted: to reject all saturated earth, to stop the works entirely during the periods of heavy rains, to revet with well-rammed earth embankments formed of clayey soil, &c. It is not possible in all cases to deposit the earth from barrows, nor to lay it in horizontal beds; these measures would be incompatible with economy and quickness in heavy work.

But, despite some addition to the cost, the work may be proceeded with as in the case of the Manchester and Bolton railway. This work was commenced by two lateral zones, which formed counterforts or feet to the slope of the embankment. Then, as soon as these zones were sufficiently raised and consolidated, a central hearting was formed between them. In difficult cases it is necessary to take more precautions, and to construct the lateral zones as projecting counterforts well bedded in the natural ground, and to execute them in stone, turf, or, more economically, in rammed earth, with inclined layers in a direction the reverse of the slope of the embankment. Thus an embankment constructed in the ordinary defective manner, with a central hearting and lateral prisms, may be thoroughly consolidated (Fig. 39) by the addition of counterforts of carefully-rammed earth, separated from the earthwork by a filter of broken stone, about 1 foot thick, or by a pile of superimposed gravel fascines. These filters keep away all water from the counterforts, which would otherwise drain into them from the embankment, It is preferable to execute these counterforts in advance with earth taken from the site, as at *a b c d e a*; by doing this they will have time to consolidate, and the proper slope can be given to enable them to stand until the filling-in is completed.

Plantations of acacias or of osiers contribute to the stability of sliding slopes. It is often useful to form, in the upper side, a lateral ditch, collecting the water of the slope and carrying it off by a culvert, without which precaution it will collect at the base of the bank.

On side-lying ground an embankment may slip even if formed in good material; it is necessary therefore in such cases to trench out the natural surface (Fig. 40) in order to give the base sufficient hold.

THE REPAIRS OF FALLEN EMBANKMENTS.

When the slope of an embankment has fallen, it is advisable to remove the foot by short lengths (35 feet at the utmost), and to replace the excavation at once with well-rammed earth in horizontal layers, or in beds inclined the reverse way of the slope. The retaining counterforts thus established ought to be kept dry; and to effect this filter-walls of broken stone or gravel fascines should be placed between the new and the old work. If the weather be favorable, there should be no danger in using for the counterfort some of the upper portion of the fallen material, as it has been exposed to the action of the air, and may be rammed freely. The Villeneuve embankment (Mulhouse railway) fell for a length of about 250 feet, and was restored for the moderate sum of £53.

M. Bruere also repaired, at a cost of £58, the Vendeuvre embankment, for a length of 230 feet. Fig. 41 shows the arrangement adopted, from which it will be seen that a portion of the fallen material was left, being covered with a counterfort of rammed earth and new ground above, while the drainage was effected by means of a gravel filter standing in a brick channel.

On the Morcerf embankment (Paris-Coulommiers railway) the filter is of broken stone, surrounded by matting. At some parts it was necessary to form two of these filters within the fallen portion of the work (Fig. 42), connecting them to-

gether and with the outside of the slope by transverse drains. Two superposed counterforts retain the filters.

At the Villiers embankments, on the Paris and Mulhouse railway, the drainage consists of a dry stone wall, which at the same time helps to retain the bank. The fallen slope was restored to its original condition by means of ballast.

On the Main-Weser railway some clay embankments slipped and were restored with sand. The result of this was that pockets filled by sand saturated with water were formed, and these could not dry on account of the clay surrounding them. The drainage was effected by making channels, in which pipes were laid, as at A B, Fig. 43. These pipes were covered with broken stone to a depth of about 5 feet, to ensure their permanent action, in spite of further settlement.

On the Wissembourg railway the sides of failing embankments were drained by means of transverse trenches, in which were placed gravel fascines (Fig. 44), afterwards covered with a facing of good earth, combined with the fallen material, and well rammed.

Slopes exposed to the action of water often require a protective stone covering, to prevent erosion. On the railway from Amsterdam to Rotterdam, fascines are employed, combined with rubble work, the whole being well secured.

The preceeding Notes have referred only to special difficulties encountered by engineers in the construction of earthworks for roads and railways, without considering many of the causes of landslips. The Author has recently (September 1874) submitted to the Institution a Memoir on the Action of Torrents, adding to it, as illustration of his remarks, a notice printed under the auspices of the Canton of Vaud, on the ravages caused in 1873 by the Garonne, a torrent of the Vaudois Alps.

These earth movements are referred to under the action of torrents and great waters, because such movements are often caused by them, although they appear remote; and it will be easily understood that if from this cause the foot of a hill has been shaken, large areas of cultivation may easily be lost. What is more curious, although belonging to the same cause, is that the works for draining marshes will often, under certain conditions and at a given moment, produce analogous accidents, with favorable results—the increase of the value of the land. For example, a short time ago some slips took place on the bank of the lake of Bienne (Switzerland, being the first results of the work of lowering the level of the lake, which is the same thing in effect as laying bare the foot of the slope which it bathes, since it deprives it of an existing counterthrust.

Since these Notes were written the Author has witnessed a disastrous landslip at Lausanne, in 1874, between the station and the town, due to the action of internal water, and at the termination of the construction of a cutting undertaken by the town for widening the railway. These works were conducted with but few precautions, in a soil where the utmost care was necessary, and where narrow headings ought to have been made, and retaining walls constructed. Whatever the cause, two houses of considerable value were destroyed, a large hotel in course of construction was so shaken that it must be taken down, and a new building which owing to its resting on piles, resisted the shock for a considerable time, is now yielding. It is true that this latter is in the vicinity of a tunnel in course of construction, and it is difficult for the moment to judge either the actual cause or the comparative success that will be attained by the system of subterranean galleries now being made to drain the soil, which consists of marl, clay, and sand. It would appear that the galleries have been driven a little too low; but it was supposed that if they were higher the inhabitants of the Rue de Midi would have been alarmed, and it is hoped they have nothing to fear. Careful investigations have been made, but the reports of successive commissions have not yet been published. No doubt a litigious discussion will take place, on acconnt of the large number of parties interested.

Invention and Introduction of the Engineer's Transit.

The first Transit instrument was made during the year 1831. It was a long stride in the improvement of Engineering instruments; and that it should to day retain its almost identical first form, proves the value of its introduction and the good judgment of the inventor. The English Theodolite, capable of performing the same work, found, if we are to credit the traditions of earlier members of the Engineering profession, but little favor with the American Engineers. Its workings were slow and inconvenient. Few cared to trust the prolongation of a straight line by reversing the Theodolite on its centre, and trusting to the vernier readings; and as few fancied the trouble of reversing the telescope on its Y bearings, "end for end." Forgetfulness in the fastening of clips resulted in a fall of the telescope, while if clips were too tight there was the danger of shifting the instrument in fastening, or if too loose the telescope rattled. Such were some of the discomforts attending the use of the Theodolite, an instrument well fitted for many purposes, and whose peculiar merits still cause many of our English brethren to cling to its use.

From the Theodolite, the change was to the Magnetic Compass. This, in its simplest form, or in its modified form, made to read full circle angles independent of the needle, was high in favor with many, especially those surveyors, who, from their local knowledge, (and some with naught besides), were selected to "run" the preliminary lines of railroads. By dint of labor, these surveyors mastered the intricacies of the vernier, but could never be brought to doubt the superior virtues of compass sights in seeing past a tree or other obstruction. With the transit the tree has to come down; they would not undertake to say the staff on the other side of a tree was in the line of the cross-web, but were sure that they could make it "just right" with the line of sights. Nevertheless, though frequently doing close work, the needle would play pranks that produced much trouble; and though to be commended for speed on the preliminary, was rather too uncertain for location.

In the year 1831, the first transit was made by Wm. J. Young. It was graduated to read by vernier to 3 minutes, it being in earlier days a favorite idea of the inventor that graduation of three minutes could be easily read to one minute, and was less perplexing to use. The instrument had an out-keeper for tallying the outs of the chain, and a universal or round level. The needle was about 5 inches; the telescope 9 inches, of low power. The standards were of almost identical pattern now used by some makers. The centre between plates was of flat style, vernier on inside of needle ring, and the plates moved upon each other by rack and pinion. The plates and telescope detached from the tripod, fastened, we believe, when attached, by a snap-dragon, as in later instruments.

For whom the first Transit was made, the records, as far as we can find them, do not positively show; as well as it can be gathered from them, and from other data, the first one was used on the state works of Pennsylvania, but whether on the Mountain Division, or on the incline plane of Columbia R. R., is uncertain.

The distinguished Engineers of the Baltimore and Ohio R. R., also claim the use of the first Transit; and as illustrative of their belief, we append the following extract from the *Railroad Journal* of December, 1855:

"The Transit is now in common use in this country, and is a comparatively cheap instrument. Such, however, is not the case in Europe. In England, the old mode is still in vogue, to a great extent, of laying out curves with the use of Ordinates; we are not sure, indeed, that any other course is not an exception."

"Some years since, Mr. Charles P. Manning, an accomplished American Engineer,—now the efficient Chief of the Alexandria, Loudoun and Hampshire R. R.,—went to Ireland, and on the Limerick and Waterford Railway, initiated the method, so common in this country, of laying out curves with the Transit."

"The first instrument of this name was made by Mr. William J. Young, the ac-

complished Mathematical Instrument Maker, of Philadelphia, for the Baltimore and Ohio Railroad Company, the Engineers of which made the first suggestions modifying the old Theodolite. We have in times past used this instrument, which is much like those made at the present time by the same manufacturer, and is, if we are not mistaken, still in the field."

"Since then, Transits have been little improved, but have been changed in the wrong direction. They are generally much heavier than formerly, containing as much brass and mahogany as one man can well stand under. This great weight is not only useless, but dangerous. Heavy instruments are much more liable than light ones to get out of adjustment on transportation—even in the ordinary field service. They are not a whit steadier in the wind; being generally made with clumsy tripods and large plates, they expose a greater area to the breeze. *If the feet of the tripod be firmly planted*, the instrument is rarely disturbed by the wind. Besides this, a heavy instrument is much more liable to danger from accident in a rough country."

And the following, from the same journal of Jan. 5, 1856:

THE FIRST TRANSIT COMPASS.

"In our issue of the 15th of December, 1855, in noticing the field book of C. E. Cross, C. E., we took occasion to state some facts concerning the first Transit Compass, an instrument made by Young, of Philadelphia. We have since then received an interesting letter from Mr. Chas. P. Manning, whom we mentioned as having initiated in Ireland the American method of laying out curves. Mr. Manning disclaims the honor in favor of 'Richard B. Osborne, Esq., an Engineer who received his professional education in the service of the Reading Railroad Co., under Messrs. Moncure and Wirt Robinson (where he finally occupied the responsible position of Chief of the Engineer Department, during the early struggles of that corporation, in its competition with its rival, the Schuylkill Navigation Co.), and from which road he went to Ireland, and took charge of the location and construction of the Waterford and Limerick Railway in 1846.'

"Mr. Manning says further: 'I obtained from Mr. Young, and sent to Ireland, probably, the first Transit Compass ever known in that country or in England, and soon afterwards joined Mr. Osborne as his Principal Assistant, for the purpose of aiding him in the effectual introduction, at least upon that road, of the American system of location and construction.'

"We were familiar with these facts when we made the statement which Mr. Manning desires corrected. But our object was not so much to mention the party to whom the credit of introduction was due, as to state a few facts immediately connected with the history of the instrument. Mr. Osborne introduced the instrument into Ireland, Mr. Manning initiated its use among the junior assistants.

"'Mr. Osborne was the first to construct an iron bridge upon the plan of Howe's Patent Truss—several of which he put upon the W. &. L. Railway; and, I believe, he also built and placed upon the same road, the first eight-wheeled double-truck passenger and freight cars (American plan) that were ever used in Great Britain.'

"Mr. Manning gives us a very entertaining sketch of the history of that first Transit, made by Young, of which we remarked that we had in time past made use.

"'Twenty and odd years ago—when a mere boy—I saw that instrument upon a lawyer's table, and afterwards in a court room—a dumb witness in behalf of the patentee. Nineteen years ago, after considerable service in tracing the centre line of the Washington Branch of the B. & O. R. R., it was used in making surveys for the extension of the last named road, westward from Harper's Ferry, and your humble servant carried and used it at that time in Washington County, Maryland, and in Ohio County, Virginia.

"'In the last seven years the instrument accompanied me as a duplicate, and was occasionally used upon the location and construction of the B. & O. R.R., through the wilderness, west of Cumberland, and now rests upon its laurels in the office of the Baltimore and Ohio R. R. Company, in Baltimore.

"'It was *instrumental* in setting the first peg that was driven for the extension of the B. & O. R. R. west of Harper's Ferry; and it was 'hard by,' and able to do duty, when the last peg was set for completing the track of that road upon the banks of the Ohio River.

"'In all material points Mr. Young has never been able to improve upon this original work of his hand, but in some of its minor parts he has effected desirable changes—such as the tangent screws connected with the clamp of the tripod—the substitution of a clamp and tangent screw for the old rack and pinion movement of the two compass plates—the subdivision of degrees into minutes, by an improved graduation of the vernier, &c.

"'The original instrument had an index for counting the number of deflections made at one sitting; also a small bubble upon the exterior of the telescope, for the purpose of defining a horizontal line, without resorting to the aid of its companion, the ordinary Level,—but these superfluities were soon thrown aside; and one of its peculiar features was, and is, a vernier, graduated only to *three* minutes,

TO BE CONTINUED.

Keel Ridge furnace, Sharon, is in the third year of its blast.

Occasional Notes on Boiler Making.

The gradual increase in high-pressure steam has caused a corresponding change in the construction of boilers. Not long ago they were made 60 lbs. working pressure, then 70 lbs., 80 lbs., up to 200 lbs., but the fickleness of public favor makes it difficult to say of what shape is to be the boiler of the future.

The Lancashire, or two-flued, undoubtedly stand first for ordinary purposes, and it is on this class of boiler more particularly that the following remarks are made The first principle to be carried out in boiler-making is, to obtain the maximum of strength with the minimum of material. A circular form is essential for this, and any departure from it will necessarily weaken the structure. Still, in both marine and locomotive practice, many irregular forms are used, with, strange to say, little likelihood of their being superseded. At any rate no recent boiler seems to be a formidable rival; yet there needs to be a thorough reform in the construction of marine boilers--something of the strongest possible shape, to generate the greatest amount of steam, in little room, under the conditions peculiar to marine engineering.

The strength of plates is greater in the direction of the fibre than across it; hence the lengthway of a plate should always be placed to take the greatest strain, or, according to present practice, round the boiler. A further advantage would be gained by bending the plates hot instead of cold. A hot plate would have the fibres gradually drawn out by rolling, and this, in rings of small diameter, is very important; for, when rolled cold, one side of the plate is put in compression and the other in tension, similar to a turning from a lathe, thus destroying to a great extent the nature of the iron. A more uniform expansion would also be insured throughout the boiler. It is still an unsettled question amongst the engineers whether punching the rivet holes injures the plates or not. One engineer calls "punching" barbarous, whilst the evidence of others shows little, if any, difference in strength between it and drilling. To drill the holes, however, after the plates are put together is decidedly best.

Drifting the rivet-holes in every case weakens the plate, and cannot be too strongly condemned, because the goodness of a boiler depends almost as much on the character of the workmanship as on the material. To be sure of having a a first-class boiler, it should be inspected when in course of erection, before the rivets are put in, and all plates found with the holes across rejected. Makers would be more particular than they are if this plan were adopted. At the same time have a small hole through the plates at every welding to ascertain whether it had been drawn out or thined in the process. It often happens, even when done by a

good workman, that a ⅛in. plate is no more than ⅛in. thick at many places in the weld. The same remark applies to dished articles, such as dome-tops and wrought-iron elbow pipes. The holes can be riveted up after inspection. Welded joints are very deceptive, and many a firm has had otherwise good boilers rejected for the reason just given.

It may not be amiss to say here that the less caulking a joint requires, the better it is. Indeed caulking at all is a bad principle. The joint ought to be made in the whole breath of the lap, instead of merely the out edges The plates must be in contact, iron to iron, to obtain such a joint. Now anybody can see that they will be out of contact on the caulking side by driving in a caulking tool or wedge, for really there is no other, so that the joint is made only by the bit of iron forced between the plates by the tool, precisely the same as a joint would be made by ramming in borings. A much better way would be to plane all the edges of the plates and fuller them. Fullering is done by a tool the the same breath as the plate is thick ; it puts no strain on the rivets, and, with a well-riveted seam, makes a tight joint. Seams may be caulked, either inside or outside, or both. One side is often sufficient.

Plates riveted by a machine are stronger than those riveted by hand, thick plates requiring a higher pressure to close them than thin ones. Joints may be made "lap," "butt," or " welded." There is no occasion for double riveting in the circular seams, though some makers adopt it.

All longitudinal seams should be double riveted, because they have to bear the greatest strain. The transverse seams have comparatively little to do, and engineers who double rivet them, to be consistent, ought to quadruple rivet the longitudinal ones. A *single* line of rivets in the transverse seam is as strong as any part of the boiler, therefore why double rivet it? Again a longitudinal seam is always weaker, or rather has more strain to take than a transverse one, where the pull is endways ; therefore, why make it no stronger than a transverse seam, for both seams are made alike when both are double riveted? By placing the joints out of a straight line, technically "breaking joint," we obtain a stronger boiler than when they are continuous. Square plating, or putting one ring outside and the next inside, alternately, is better than thimble plating, which has one edge outside and and the other inside, though the thimble plating has the advantage of not exposing the seams direct to the flame. All flues and tubes exposed to a collapsing pressure should be welded and the welding placed below the fire level, or at the bottom when the heat passes through them. This must be done whether the joint is lapped or welded, for obvious reason.

It is now possible to get a flue much stronger than the shell itself by using the flange seam, which, when placed at proper intervals throughout the length of flue, enables it to stand an enormous pressure without yielding the slightest, whilst the shell would tear like paper under the same pressure. It is also elastic, and allows the flue to expand without thrusting the end plates out. Another great advantage is, that all the rivets are surrounded by water, and no rivet-heads exposed to the action of the flame. Rivet-heads and double thicknesses of plate, over or near the fire, should be avoided as much as possible Steel plates are now largely used for the fire-boxes of flues from their non-liability to blister like iron, but they ought always to be tested before use. This is easily done by shearing a strip of each plate to double up the without breaking, or by drilling a ⅝in. hole in and driving a succession of taper punches through, until the hole is enlarged to ½ in., without fracturing the plale.

Circulation tubes welded in the flues add greatly both to strength and economy. The angle-irons should also be welded, not made with a jump joint, and end plates made in one piece. Angle-irons may be dispensed with by flanging the end plates, with increase of strength besides doing away with one ring of rivets. A drawback to the use angle-irons for fastening on the end is, that it puts all the pull on the rivet-heads, which are only capable of bearing about one-third as much as the body of the rivet when in a shearing strain. The ends require well staying with either gusset or longitudinal stays, under any circumstances.

Boilers are damaged greatly by cutting large holes in the shell for mounting, such as man-holes. When such is the case a piece of wrought-iron riveted round the hole inside will strengthen it immensely. For pressure above 80 lbs., wrought-iron is preferable to cast for man-holes, and two in number should be used, one at the back end on the top, and another on bottom of front end plate, to create a draught for cooling boiler as well as getting under the flues.

To have a boiler well mounted is an important point which should not be lost sight of and shall be considered in a future chapter.

Finally, the test of a boiler ought to be made with water, and should not be above one and three-quarter times its working pressure, nor continued too long.—*English Mechanic.*

OUR cotemporary, the *American Engineer* of Baltimore, comes to us this month greatly enlarged in size and improved in every way over its volumes of the past. It is now the leading mechanical journal south of New York city, and as a medium for inventors and others interested in Patent Office matters we should judge, from its advertising columns, to be in considerable favor.

United States Board appointed to test Iron, Steel and other Meals.

July 19th. 1875.

A Committee of the United States Board appointed to test iron, steel and other metals has been instructed " to arrange and conduct experiments to determine the laws of resistance of beams, girders, and columns, to change of form, and to fracture."

This Committee, desiring to attract to this branch of the inquiry the best talent and experience of the country, in order to reach results of the greatest practical value, solicits ths aid and co-operation of all who manufacture or use beams, girders or columns.

Many experiments have been made by the rolling-mills engaged in the manufacture of wrought iron beams, the results of which have doubtless been carefully recorded and tabulated. The Committee earnestly asks copies of such records and tables. Engineers, architects and manufacturers, have also made many experiments upon cast iron beams and riveted wrought-iron struts and girders, the results of which are respectfully requested by the Committee.

It is desirable that information as full as may be attainable, with reference to the constitution and manufacture of the iron used in making the pieces tested, should accompany reports of experiments, especially chemical analyses of the metal where these have been carefully made.

The proportions of the various parts of the samples tested should be exactly given ; and in all riveted work the size and position of the rivets should be clearly set forth. In all cases the modes of applying and measuring the strains should be given.

Accurate cross sections of the samples tested, drawn to scale, large enough to admit of reliable measurements, will greatly facilitate a proper understanding and analysis of the results.

During the construction of the machinery ordered by the Board, the Committee desires to collect information as above, and to make such experinents as seem practicable by the use of dead loads. For these experiments, and for those which will be made when the machinery is ready for use, manufacturers are asked to supply such beams, girders and columns as they may desire to have most carefully and impartially tested.

It may be of interest to those who are thus asked to contribute costly articles for destruction by tests, to be informed that the machinery ordered is believed to be the best yet designed for testing purposes, and to possess all the nicety and accuracy attainable with the present knowledge of machine construction. The first machine will have a capacity of four hundred tons (800,000 lbs.); and this will be replaced by another of one thousand tons (2,000,000 lbs.) capacity at an early day.

All suggestions as to the kind of tests to be made and the manner of making them, calculated to give them the greatest practical value, will be gladly received ; and for these and all other assistance rendered, proper acknowledgments will be made.

Sample beams, girders or columns, furnished for test, should be stamped at one end with a distinguishing number, trade-mark and initials of the maker, and forwarded to Col. T. T. S. Laidley, President of the Board, at Watertown Arsenal, Watertown, Massachusetts.

Reports of tests already made, and all other information herein asked for, may be forwarded to the Chairman of this Committee, at Maywood, Illinois.

WM. SOOV SMITH, C. E., *Chairman*,
Maywood, Ill.

LIEUT.-COL. Q. A. GILLMORE, U. S. A.,
Army Building, New York City.

CHIEF-ENGINEER D. Smith, U. S. N.,
Washington, D. C.

ASPHALT PAVEMENT.—Columbus, Ohio, is paving its main street with the Parisen patent material, consisting of a composition of Cuban asphalt and other materials, which forms a smooth and hard surface. The street is first covered with broken rock and leveled up with finely broken stone and sand, upon which the melted composition is poured, then rolled with a heavy roller. The Company have given bonds guaranteeing the work to last good for seven years.